TENT COOPERATION TR[illegible]

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 13 July 2000 (13.07.00)	
International application No. PCT/SE99/02127	**Applicant's or agent's file reference** 20326 PCT
International filing date (day/month/year) 19 November 1999 (19.11.99)	**Priority date** (day/month/year) 19 November 1998 (19.11.98)
Applicant TROIVE, Lars et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

07 June 2000 (07.06.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Manu Berrod
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

F ENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

BJERKÉN, Håkan
Bjerkéns Patentbyrå KB
Box 1274
S-801 37 Gävle
SUÈDE

Date of mailing (day/month/year)
13 juin 2001 (13.06.01)

Applicant's or agent's file reference
20326 PCT

IMPORTANT NOTIFICATION

International application No.
PCT/SE99/02127

International filing date (day/month/year)
19 novembre 1999 (19.11.99)

1. The following indications appeared on record concerning:

[X] the applicant [X] the inventor [ ] the agent [ ] the common representative

Name and Address
TROIVE, Lars
Prästkragsvägen 46
S-791 38 Borlänge
Sweden

State of Nationality: SE
State of Residence: SE
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [ ] the name [X] the address [ ] the nationality [ ] the residence

Name and Address
TROIVE, Lars
Prästkragsvägen 46
S-791 38 Falun
Sweden

State of Nationality:
State of Residence:
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[ ] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

Authorized officer
J. Leitao
Telephone No.: (41-22) 338.83.38

09 / 6223

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
20326PCT J1 le		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/SE99/02127	19.11.1999	19.11.1998
International Patent Classification (IPC) or national classification and IPC7		
B22F 3/02, B21J 5/00		
Applicant		
HYDROPULSOR AB et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
07.06.2000	22.02.2001
Name and mailing address of the IPEA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Nils Engnell/MP Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE99/02127

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed

☐ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE99/02127

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-16,17-22	YES
	Claims		NO
Inventive step (IS)	Claims	1-16,17-22	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-22	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The invention

The invention relates to a method for deformation of a body, the body being solid or being a powder mass in a mould. The body is hit by a stamping member with such a velocity that at least one rebound is generated while permanently deforming the body. The method is characterised in that the rebound is counteracted so that at least one additional impact of the stamping member is generated. Thereby an additional deformation of the body takes place.

The invention also relates to a device for deformation of a body. The device has a design corresponding to the method.

Documents cited in the International Search Report

D1 WO 9700751 A1
D2 DE 2 338 221 A1
D3 Derwent´s Abstracts, No 48412 B/26, week 7926, abstract of SU 621 434
D4 US 3 898 834 A
D5 EP 22 433 A1

Discussion

The documents were cited to define the general state of the art, which is not considered to be of particular relevance.

D1 relates to a device for cutting metal rods and compacting powder adiabatically by impacts. The concept of counteracting rebounds is not stated.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

D2 relates to a method and a device to regulate the impact energy with relation to the deformation resistance in a work piece. The concept of counteracting rebounds is not stated.

D3 relates to a method to deform metal bodies in a press. The stamp is moved at constant speed a predetermined distance and is held while sustaining the force to let a relaxation process take place. The concept of counteracting rebounds is not stated.

D4 relates to a conventional pressing method modified in that there is only one strike at a time. After a strike, the stamp is directly withdrawn, in opposition to the present invention.

D5 relates to a method of compacting and simultaneously sintering an amorphous alloy by a rapid blow. The concept of counteracting rebounds is not stated.

Conclusion

The method according to present claims 1-16 and the device according to present claims 17-22 are novel and are not considered to be obvious to a person skilled in the art. Industrial applicability is at hand.

RECORD COPY

09/856223

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/SE99/02127

International Filing Date 19-11-1999

The Swedish Patent Office
PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 20326 PCT

Box No. I TITLE OF INVENTION "A method and a device for deformation of a material body"

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

Hydropulsor AB
P.O.Box 2023
SE-691 02 KARLSKOGA
Sweden

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(that is, country)* of nationality: Sweden

State *(that is, country)* of residence: Sweden

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

TROIVE Lars
Prästkragsvägen 46
SE-791 38 BORLÄNGE
Sweden

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: Sweden

State *(that is, country)* of residence: Sweden

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☐ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

BJERKÉNS PATENTBYRÅ KB, represented by
BJERKÉN, Håkan; OLSSON, Jan; BERGLUND, Stefan or
ISRAELSSON, Stefan
Box 1274
SE-801 37 GÄVLE
Sweden

Telephone No. +46 26 10 05 50

Facsimile No. +46 26 14 30 45

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

PCT/SE99/02127
19.11.1999

Sheet No. 2.....

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

BERGSTRÖM Yngve
Solvarbo 253
SE-783 95 GUSTAFS
Sweden

This person is:
- [ ] applicant only
- [x] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: Sweden

State *(that is, country)* of residence: Sweden

This person is applicant for the purposes of:
- [ ] all designated States
- [ ] all designated States except the United States of America
- [x] the United States of America only
- [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- [ ] all designated States
- [ ] all designated States except the United States of America
- [ ] the United States of America only
- [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- [ ] all designated States
- [ ] all designated States except the United States of America
- [ ] the United States of America only
- [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- [ ] applicant only
- [ ] applicant and inventor
- [ ] inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- [ ] all designated States
- [ ] all designated States except the United States of America
- [ ] the United States of America only
- [ ] the States indicated in the Supplemental Box

- [ ] Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

- ☒ **AP** **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **SD** Sudan, **SL** Sierra Leone, **SZ** Swaziland, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ **EA** **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP** **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA** **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

- ☒ **AE** United Arab Emirates
- ☒ **AL** Albania
- ☒ **AM** Armenia
- ☒ **AT** Austria
- ☒ **AU** Australia
- ☒ **AZ** Azerbaijan
- ☒ **BA** Bosnia and Herzegovina
- ☒ **BB** Barbados
- ☒ **BG** Bulgaria
- ☒ **BR** Brazil
- ☒ **BY** Belarus
- ☒ **CA** Canada
- ☒ **CH and LI** Switzerland and Liechtenstein
- ☒ **CN** China
- ☒ **CU** Cuba
- ☒ **CZ** Czech Republic and utility model
- ☒ **DE** Germany and utility model
- ☒ **DK** Denmark and utility model
- ☒ **EE** Estonia
- ☒ **ES** Spain
- ☒ **FI** Finland and utility model
- ☒ **GB** United Kingdom
- ☒ **GD** Grenada
- ☒ **GE** Georgia
- ☒ **GH** Ghana
- ☒ **GM** Gambia
- ☒ **HR** Croatia
- ☒ **HU** Hungary
- ☒ **ID** Indonesia
- ☒ **IL** Israel
- ☒ **IN** India
- ☒ **IS** Iceland
- ☒ **JP** Japan
- ☒ **KE** Kenya
- ☒ **KG** Kyrgyzstan
- ☒ **KP** Democratic People's Republic of Korea
- ☒ **KR** Republic of Korea
- ☒ **KZ** Kazakhstan
- ☒ **LC** Saint Lucia
- ☒ **LK** Sri Lanka
- ☒ **LR** Liberia
- ☒ **LS** Lesotho
- ☒ **LT** Lithuania
- ☒ **LU** Luxembourg
- ☒ **LV** Latvia
- ☒ **MD** Republic of Moldova
- ☒ **MG** Madagascar
- ☒ **MK** The former Yugoslav Republic of Macedonia
- ☒ **MN** Mongolia
- ☒ **MW** Malawi
- ☒ **MX** Mexico
- ☒ **NO** Norway
- ☒ **NZ** New Zealand
- ☒ **PL** Poland
- ☒ **PT** Portugal
- ☒ **RO** Romania
- ☒ **RU** Russian Federation
- ☒ **SD** Sudan
- ☒ **SE** Sweden
- ☒ **SG** Singapore
- ☒ **SI** Slovenia
- ☒ **SK** Slovakia and utility model
- ☒ **SL** Sierra Leone
- ☒ **TJ** Tajikistan
- ☒ **TM** Turkmenistan
- ☒ **TR** Turkey
- ☒ **TT** Trinidad and Tobago
- ☒ **UA** Ukraine
- ☒ **UG** Uganda
- ☒ **US** United States of America
- ☒ **UZ** Uzbekistan
- ☒ **VN** Viet Nam
- ☒ **YU** Yugoslavia
- ☒ **ZA** South Africa
- ☒ **ZW** Zimbabwe

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- ☒ CR Costa Rica [(from August 3, 1999)]
- ☒ DM Dominica [(from August 7, 1999).]

Declared none

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 19 November 1998	9803956-3	Sweden		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): (1)

** Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*: ISA/ SE

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority)*: Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets**:

request	:	4 ✓
description (excluding sequence listing part)	:	~~13~~ 12 ✓
claims	:	4 ✓
abstract	:	1 ✓
drawings	:	~~24~~ ✓
sequence listing part of description	:	
Total number of sheets	:	~~23~~ 26 ✓

This international application is **accompanied by** the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☐ other *(specify)*:

RO/SE

Figure of the drawings which should accompany the abstract: 1

Language of filing of the international application: Swedish

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

HYDROPULSOR AB
by
BJERKÉNS PATENTBYRÅ KB

Håkan Bjerkén Gävle November 18, 1999

For receiving Office use only

1. Date of actual receipt of the purported international application: 19-11-1999	2. Drawings: ☒ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	
5. International Searching Authority (if two or more are competent): ISA/ SE	6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau: 20 JANUARY 2000 (20.01.00)

Sökande: Hydropulsor AB

Förfarande och anordning för deformation av en materialkropp

UPPFINNINGENS BAKGRUND OCH TIDIGARE TEKNIK

Den föreliggande uppfinningen avser ett förfarande för deformation av en materialkropp, vid vilket ett stämpelorgan med en massa m förs mot och träffar en materialkropp med en sådan hastighet att åtminstone en återstudsrörelse hos stämpelorganet genereras, under det att en permanent deformation av kroppen genereras. Uppfinningen avser dessutom en anordning för deformation av en materialkropp, innefattande ett stämpelorgan inrättat att föras mot och träffa en materialkropp med en sådan hastighet att en återstudsrörelse hos stämpelorganet genereras, under det att en permanent deformation av materialkroppen genereras.

Genom sökandens tidigare patentansökan nr WO 97/00751 är det känt att fixera en materialkropp, antingen i solid form eller i form av ett pulver av korn, pellets eller liknande och med ett enda eller flera på varandra följande slag medelst en slagenhet åstadkomma adiabatisk koalescens i materialkroppen, varigenom en snabb och effektiv deformation av materialkroppen erhålls.

Enligt denna tidigare teknik bör, då ett flertal på varandra följande slag appliceras på kroppen, intervallet mellan de på varandra följande slagen vara mindre än approximativt 0,2 sekunder. Vid kompaktering av pulver, företrädesvis metallpulver, föreslås att tre på varandra följande slag appliceras mot materialkroppen. Av dessa slag är det första ett extremt lätt slag som tvingar ut den mesta luften från pulvret och orienterar pulverpartiklarna. Det påföljande slaget har mycket hög energi och hög slaghastighet i

syfte att åstadkomma lokal adiabatisk koalescens hos pulverpartiklarna så att dessa pressas samman till extremt hög densitet. Det tredje slaget har mellanhög energi, d v s lägre energi än det andra slaget, och åstadkommer slutlig formning av materialkroppen, vilken därefter kan sintras. Vid motsvarande deformation av en solid metallkropp kommer glidplan att under en kraftig lokal temperaturökning i materialet aktiveras, varigenom den erfordrade deformationen uppnås.

I bägge de beskrivna fallen kommer emellertid en mycket kraftig impuls från slagenheten att erfordras för att uppnå den avsedda deformationsverkan då ett enda slag eller flera slag med ett mellanrum i storleksordningen 200 ms används för att uppnå det önskade målet. Slagverktyget, eller stämpelorganet, tillåts att studsa tillbaka mellan varje enskilt slag. Det är därvid ej i kontakt med materialkroppen mellan slagen, utan enbart en gång per slag. Slaget eller slagen ger en lokalt mycket kraftig höjning av temperaturen i materialet hos den deformerade kroppen. Då kroppens material innefattar en eller flera metaller eller metallegeringar resulterar vanligtvis en sådan kraftig temperaturhöjning i fasövergångar hos materialet, både då det värms upp och då det därefter kyls. Kylningen kan dessutom ofta ske relativt snabbt, eftersom temperaturhöjningen ofta är lokal och värmen kan ledas bort via det omgivande, kallare materialet. Sannolikheten är stor att oönskade strukturer och faser, t ex martensit i stål, erhålls som ett resultat av denna process.

SAMMANFATTNING AV UPPFINNINGEN

Ett syfte med den föreliggande uppfinningen är att tillhandahålla ett förfarande, medelst vilket en deformation av en materialkropp av det inledningsvis nämnda slaget utförs med en så låg temperaturhöjning i materialkroppen som möjligt under det att en fullgod deformation av materialkroppen alltjämt uppnås. Därigenom skall förfarandet göra det möjligt att i stor utsträckning undvika uppkomsten av ofördelaktiga faser och strukturer i materialkroppen på grund av alltför kraftiga temperaturvariationer i denna.

Uppfinnaren har vid praktiska experiment upptäckt att fram- och återgående vågor genereras i materialkroppen i det ögonblick då stämpelorganet studsar tillbaka från materialkroppen. Dessa vågor definierar en kinetisk energi i materialkroppen, vilken energi successivt, i sekvenser, aktiverar glidplan i kroppen och förmodligen även orsakar inbördes förskjutningar av korn hos ett pulver under det att nämnda vågor snabbt avklingar. Försök har gjorts med materialkroppar av stål, vilka placerats på ett underlag och vilka deformerats medelst ett stämpelorgan som träffat dessa vertikalt ovanifrån. Det har därvid noterats att de fram- och återgående vågorna förflyttar sig fram och tillbaka väsentligen i stämpelorganets anslagsriktning, d v s från den yta hos materialkroppen som träffats av stämpelorganet till den yta som anligger mot underlaget och åter. Hos sådana provmaterialkroppar av stål avklingar nämnda vågor så mycket att de ej längre genererar någon nämnvärd deformation i materialet inom loppet av ett fåtal millisekunder.

Syftet med uppfinningen har uppnåtts medelst ett förfarande av det inledningsvis nämnda slaget, vilket är kännetecknat av att stämpelorganets återstudsrörelse motverkas, varigenom åtminstone en ytterligare stöt av stämpelorganet mot materialkroppen genereras inom en period, under vilken kinetisk energi i materialkroppen genererar en ytterligare deformation av denna. Den åtminstone ena ytterligare stöten tillför därvid energi till materialkroppen i sådan utsträckning att den bidrar till den kinetiska energin hos den fram- och återgående vågen, varigenom en ytterligare deformation av kroppen som åstadkoms av nämnda våg fortgår under en längre period än om ej någon omedelbar återstöt av stämpelorganet utförts. Den ytterligare deformation som åstadkoms av vågen kan innefatta enbart glidplansaktivering, och/eller inbördes förskjutningar av korn i fallet med en pulverkropp. Den ytterligare stöten, vilken har en viss impuls och tillför en viss energi, kommer, tack vare den ytterligare deformation som vågen åstadkommit, att ytterligare plastiskt deformera kroppen. En betydligt mindre impuls erfordras för en given deformation vid denna tidpunkt, då fler glidplan är aktiverade, än vad

som skulle ha varit fallet om den ytterligare stöten applicerats vid ett senare tillfälle, då nämnda våg redan hade avklingat.

Uppfinnaren har upptäckt att en lägre total energi behöver tillföras materialkroppen och att en förhållandevis låg temperaturhöjning i materialkroppen kan uppnås under det att den önskade deformationen av materialkroppen fortfarande uppnås med hjälp av det uppfinningsenliga förfarandet.

Enligt ett föredraget utförande av det uppfinningsenliga förfarandet appliceras en serie stötar med hjälp av stämpelorganet mot materialkroppen inom nämnda period. Genom en serie av snabba stötar tillförs materialkroppen kontinuerligt kinetisk energi som bidrar till att hålla den fram- och återgående vågen vid liv och således gynnar fortsatt generering av den ytterligare deformationen i materialkroppen samtidigt som varje ny stöt genererar en ytterligare plastisk, permanent deformation av kroppen. Serien av stötar åstadkoms genom att en motsvarande serie av återstudsar hos stämpelorganet motverkas och en ny respektive stöt åstadkoms, vilken i sin tur genererar en ny återstuds. Varje impuls, med vilken stämpelorganet träffar materialkroppen är således stor nog att generera en återstuds hos stämpelorganet inom nämnda serie. Då flera på varandra följande slag appliceras mot materialkroppen för deformation av denna appliceras nämnda serie av stötar i direkt anslutning till respektive slag. Slaget definierar den första stöten i respektive serie av stötar.

Enligt ytterligare ett föredraget utförande sjunker den impuls, med vilken stämpelorganet träffar materialkroppen för varje stöt inom nämnda serie. Då ett slag som endast innefattar två stötar, en första och en andra sådan, appliceras mot materialkroppen, har den första stöten en större impuls än den andra. Tack vare vågens effekt på materialkroppen är det inte längre nödvändigt med en lika stor impuls från den andra stöten för att generera en viss önskad ytterligare plastisk deformation. Det blir även i praktiken enklare att åstadkomma en andra stöt med en mindre impuls än den första stöten inom en så kort tidsperiod som det rör sig om här (approximativt 1 ms), exempelvis genom effektiv

dämpning av återstudsrörelsen. Möjligheten att applicera en andra stöt med en större impuls än den första eller föregående stöten skall emellertid inte uteslutas, om så fordras.

Enligt ett ytterligare föredraget utförande är materialkroppen en solid kropp som innefattar ett metallmaterial, varvid nämnda deformation innefattar en omformning av kroppen. Den ytterligare deformationen sker därvid genom att den kinetiska energin hos den fram- och återgående kroppen genererar en successiv aktivering av glidplan i materialkroppen. Genom att glidplanen aktiveras successivt kan en långsammare och mindre intensiv deformation av materialet åstadkommas genom appliceringen av en eller flera ytterligare stötar utöver den första mot materialkroppen. Temperaturhöjningen i materialkroppen behöver därmed inte bli så stor som då en motsvarande deformation av kroppen skall uppnås medelst en enda stöt, efter vilken den fram- och återgående vågen i materialkroppen tillåts att avklinga utan att någon ytterligare energi till denna tillförs utifrån.

Enligt ytterligare ett föredraget utförande innefattar materialkroppen ett pulver, anordnat i en form. Deformationen av pulverkroppen innefattar en kompaktering därav. Det uppfinningsenliga förfarandet erbjuder ett snabbt och effektivt sätt att kompaktera pulver på, t ex hårdmetallpulver, utan att onödigt höga temperaturer, som skulle kunna leda till bildande av oönskade strukturer och /eller faser, genereras i pulvret. Såsom nämnts ovan föreslår tidigare teknik att pulvermaterialkroppen kompakteras i tre steg, ett första steg då ett lätt slag appliceras mot kroppen i syfte att åstadkomma en initial orientering av pulverpartiklarna, ett andra steg då ett mycket kraftigt slag riktas mot pulvret för att åstadkomma lokal adiabatisk koalescens hos pulverpartiklarna så att dessa pressas samman till hög densitet, och ett tredje steg, vid vilket ett slag med medelhög energi appliceras mot pulverkroppen och en slutlig formning äger rum. Det uppfinningsenliga förfarandet skulle med fördel kunna tillämpas vid det andra steget och/eller eventuellt vid det tredje steget.

Ett ytterligare syfte med uppfinningen är att tillhandahålla en anordning, medelst vilken det är möjligt att bearbeta en materialkropp med hjälp av ett stämpelorgan som träffar materialkroppen med en sådan impuls att en adiabatisk koalescens erhålls i materialkroppen, varvid en minimal temperaturhöjning åstadkoms i kroppen samtidigt som den eftersträvade deformationen erhålls.

Detta syfte uppnås medelst en anordning av det inledningsvis definierade slaget, vilken är kännetecknad av att den innefattar medel för att motverka återstudsen och för att generera en ytterligare stöt av stämpelorganet mot materialkroppen inom en period, under vilken kinetisk energi i materialkroppen genererar en ytterligare deformation i denna.

Enligt ett föredraget utförande är stämpelorganets rörelseväg mot materialkroppen sådan att kroppen accelereras under inverkan av den gravitationskraft som verkar på denna och återstudsen motverkas av gravitationskraften. Därigenom kan stämpelorganets egen massa utnyttjas för att generera den ytterligare stöt som riktas mot kroppen. Företrädesvis tillåts stämpelorganet falla väsentligen vertikalt i riktning mot materialkroppen, varigenom gravitationskraften utnyttjas maximalt för att motverka återstudsen hos stämpelorganet.

Enligt ytterligare ett föredraget utförande innefattar anordningen medel för att applicera en kraft F_1 på stämpelorganet, vilken kraft verkar i riktning mot materialkroppen och motverkar återstudsen. Genom ett lämpligt val av stämpelorganets massa, fallhöjd och storlek på den applicerade kraften F_1 är det sålunda möjligt att styra tiden mellan två på varandra följande stötar av stämpelorganet mot materialkroppen. Den applicerade kraften F_1 motverkar inte enbart återstudsen utan bidrar även till att aktivt skjuta stämpelorganet i riktning mot materialkroppen.

Enligt ytterligare ett föredraget utförande är anordningen anordnad att utföra en serie stötar medelst stämpelorganet mot materialkroppen inom nämnda period. Varje enskild stöt sker därvid med en sådan hastighet hos stämpelorganet att en efterföljande

återstuds av detta genereras. Anordningen kan därvid innefatta medel för att styra storleken på den på stämpelorganet applicerade kraften, t ex så att denna successivt avtar för varje ytterligare återstuds i syfte att åstadkomma en harmonisk och inte alltför snabb dämpning av stämpelorganets rörelser mot materialkroppen.

Enligt ytterligare ett föredraget utförande sjunker den impuls, med vilken stämpelorganet träffar materialkroppen för varje stöt inom nämnda serie. Framför allt är skillnaden i impuls stor mellan den första stöten och den andra stöten. De respektive impulserna bidrar till att förhindra att den fram- och återgående vågen i materialkroppen avklingar för snabbt. På detta vis tillförs energi i form av kinetisk energi till materialkroppen inom en period, under vilken den kinetiska energin på effektivaste sätt genererar en deformation i materialkroppen. Såsom nämnts ovan innefattar den ytterligare deformation som vågen genererar i kroppen glidplansaktivering. Varje ytterligare stöt inom nämnda period drar fördel därav för att generera en ytterligare plastisk deformation av materialkroppen under det att nämnda glidplan ännu är aktiverade.

Ytterligare särdrag hos och fördelar med uppfinningen kommer att framgå av den fortsatta beskrivningen och av de övriga patentkraven.

KORT BESKRIVNING AV RITNINGARNA

Uppfinningen skall härefter i exemplifierande syfte beskrivas med hänsyn till de bifogade ritningarna, på vilka:

fig. 1 är en schematisk tvärsnittsvy från sidan, som visar en anordning för deformation av en solid kropp,

fig. 2 är en schematisk tvärsnittsvy från sidan som visar en likadan anordning för kompaktering av ett pulver,

fig. 3 är ett diagram som schematiskt visar en registrerad förskjutning av ett stämpelorgan enligt fig. 1 eller 2 med tiden,

fig. 4 är ett diagram som schematiskt visar den axiella hastigheten hos stämpelorganet respektive en yta hos materialkroppen enligt fig. 1 med tiden,

fig 5 är ett diagram som visar, i ett experiment med pulverkompaktering, både stämpelorganets rörelse över tiden och den kraft med vilken stämpelorganet påverkar pulvermaterialet under kompakteringsförloppet,

fig 6 ett diagram som beskriver stämpelorganets läge som funktion av tiden vid deformation (formning) av en solid kropp, och

fig 7 en förstoring av det tredje i fig 6 framgående formningssteget.

DETALJERAD BESKRIVNING AV FÖREDRAGNA UTFÖRANDEN

I fig. 1 och 2 visas schematiskt en anordning för deformation av en materialkropp 1. Anordningen innefattar ett stämpelorgan 2, vilket inrättat att föras mot och träffa materialkroppen 1 med en sådan hastighet att en återstudsrörelse hos stämpelorganet 2 genereras. Därvid deformeras materialkroppen 1.

Materialkroppen 1 i fig. 1 är bildad av ett material i fast form, företrädesvis en solid metall. I fig. 2 är materialkroppen 1 bildad av ett pulver som företrädesvis redan är lätt kompakterat, antingen medelst ett lätt slag av stämpelorganet eller något annat liknande organ. Anordningen är inrättad att medelst ett kraftfullt slag av stämpelorganet åstadkomma en omedelbar och relativt stor deformation av materialkroppen 1.

Stämpelorganet 2 är så anordnat att det under påverkan av den gravitationskraft som verkar på detta accelereras mot materialkroppen 1. Stämpelorganets 2 massa m är företrädesvis väsentligt större än materialkroppens 1 massa. Därigenom kan behovet av en hög anslagshastighet hos stämpelorganet 2 reduceras något. Stämpelorganet 2 tillåts träffa materialkroppen 1 med en sådan hastighet att en lokal adiabatisk koalescens och en där-

med associerad deformation i materialkroppen 1 erhålls. Hastigheten är dessutom sådan att en återstuds av stämpelorganet 2 genereras. Den deformation av materialkroppen 1 som därvid åstadkoms är plastisk och följaktligen permanent. Då stämpelorganet 2 återstudsar genereras kraftiga vågor eller vibrationer i materialkroppen 1 i stämpelorganets 2 slagriktning. Vågorna förstärks inledningsvis då stämpelorganet 2 inte är i omedelbar kontakt med materialkroppen 1 . Denna våg eller dessa vågor har en hög kinetisk energi och kommer att aktivera glidplan i materialkroppen som ej varit aktiverade under den föregående stöten. Under den period, då dessa glidplan är aktiverade, kommer materialkroppen 1 att vara relativt sett enklare att deformera med en given impuls eller energi hos en nästföljande stöt. Anordningen är därför så anordnad att en tillräcklig kraft verkar på stämpelorganet 2 i riktning mot materialkroppen 1 för att en ytterligare stöt, med en impuls som överstiger ett minimumvärde, genereras mot materialkroppen 1 inom nämnda period. Perioden är emellertid mycket kort, i storleksordningen ett fåtal millisekunder. Om stämpelorganets 2 massa är mycket stor skulle det i och för sig vara möjligt att åstadkomma nämnda ytterligare stöt inom denna period genom att enbart låta gravitationskraften verka på stämpelorganet 2 och dämpa återstudsen och accelerera stämpelorganet mot materialkroppen 1.

Enligt det visade, föredragna utförandet av anordningen, innefattar den senare emellertid ett medel 3 för att applicera en kraft F_1 på stämpelorganet 2, vilken kraft verkar i riktning mot materialkroppen 1 och motverkar återstudsen. Detta medel 3 kan innefatta en kraftcylinder, t ex en hydraulcylinder. Den har inte enbart till uppgift att motverka stämpelorganets 2 återstudsrörelse, utan även att accelerera stämpelorganet 2 mot materialkroppen 1 och därigenom bidra till den impuls, med vilken stämpelorganet 2 träffar materialkroppen 1 vid den påföljande stöten. Företrädesvis är kraften F_1, stämpelorganets 2 förflyttningsbana och rörelseriktning mot materialkroppen 1 samt stämpelorganets 2 massa m, anpassade så att en ytterligare stöt, företrädesvis flera ytterligare stötar, vilka var och en bidrar till att förlänga nämnda

period och stegvis ytterligare plastiskt deformera materialkroppen 1, genereras.

Fig. 3 visar schematiskt den axiella förskjutningen av stämpelorganet 2 med tiden från det ögonblick då stämpelorganet 2 träffar materialkroppen 1 och börjar deformera denna till den tidpunkt, då vågen eller vågorna i materialkroppen 1 avklingat och ytterligare eventuella återstudsar och stötar från stämpelorganet inte längre genererar någon väsentlig ytterligare deformation av materialkroppen 1. Diagrammet är bildat utifrån ett försök, vid vilket ett stämpelorgan 2 med en massa av 105 kg användes för att deformera en cylinder med höjden 20 mm och diametern 12 mm, gjord av mjukglödgat lagerstål. Medelst en hydraulkolv applicerades dessutom 50 kN på stämpelorganet 2 i riktning mot materialkroppen 1, d v s stålcylindern.

Den hastighet, med vilken stämpelorganet 2 tilläts träffa materialkroppen 1 varierades vid olika försök. Vid det försök som genererade ett diagram, som approximativt motsvaras av diagrammet i fig. 3, uppmättes hastigheter i axiell riktning hos stämpelorganet 2 och erhölls genom en beräkningsmodell en schematisk bild över en typisk hastighet hos materialkroppen 1 i axiell riktning, vilka hastigheter är approximativt åskådliggjorda i fig. 4. Linjen a markerar hastigheten hos stämpelorganet och linje b markerar hastigheten hos materialkroppen. Det syns tydligt hur en våg, d v s en fram- och återgående rörelse, genereras i materialkroppen 1 så snart stämpelorganets 2 återstudsrörelse påbörjats. Detta sker vid det åskådliggjorda försöket efter approximativt 3 ms. En millisekund senare, d v s efter 4 ms, utför anordningen nästa stöt.

I stötögonblicket, då stämpelorganet 2 och materialkroppen 1 är kontakt med varandra och materialkroppen 1 deformeras under inverkan av stämpelorganets 2 impuls, avtar amplituden hos vågen i materialkroppen 1 något, för att sedan åter tillta i storlek då stämpelorganet 2 åter studsar tillbaka och helt eller delvis förlorar kontakten med materialkroppen 1 under ett kort ögonblick. Perioden mellan två på varandra följande stötar är av storleks-

ordningen 1 ms. Efter en viss tid, här i storleksordningen 5 ms, har vågen i materialkroppen 1 emellertid avklingat så mycket att den ej längre bidrar till att aktivera ytterligare glidplan. Ytterligare stötar från stämpelorganet 2 kommer därvid inte att i någon anmärkningsvärd utsträckning bidra till någon ytterligare plastisk deformation av materialkroppen 1, så länge som ej några radikala åtgärder vidtas, t ex en markant höjning av den kraft, med vilken stämpelorganet 2 påverkas. Då detta stadium uppnåtts kan stämpelorganet lämpligtvis återföras till ett läge, utifrån vilket en ny, motsvarande serie av stötar mot en ytterligare materialkropp 1 eller samma materialkropp 1 utförs.

Det bör nämnas att en fram- och återgående våg kan uppträda i materialkroppen 1 även under den inledande plastiska deformationen av denna, d v s innan återstudsrörelsen hos stämpelorganet 2 genererats, men att denna våg har en väsentligt lägre amplitud än då återstudsrörelsen genererats. Av tydlighetsskäl är inte någon fram- och återgående våg hos materialkroppen 1 vid den inledande deformationen därav visad i fig. 4.

I fig 5 anger abskissan tiden (millisekunder) medan ordinatan anger stämpelorganets rörelsesträcka vad avser den med 4 betecknade grafen medan ordinatan avser kraft beträffande den med 7 betecknade grafen. Som tidigare nämnts beskriver stämpelorganet en återstudsrörelse under ett formningssteg. I diagrammet enligt fig 5 redovisar grafen 4 stämpelorganets rörelse vid utfört experiment med pulverkompaktering. Grafen 7 beskriver den kraft med vilken stämpelorganet påverkar pulvermaterialet som kompakteras.

Ur diagrammet i fig 5 kan man, vad avser kompakteringsfasen angiven med 6, se hur kraften (grafen 7) i pulvermaterialet stiger vid varje återstuds av stämpelorganet, grafen 4. Vidare framgår hurusom stämpelorganet intager en allt lägre position efter varje återstuds, se grafen 4, och därmed ger pulvermaterialet en allt högre kompakteringsgrad. Efter att stämpelorganets rörelse klingat av styrs stämpelorganet så småningom upp till parke-

ringsläget enligt graf 4. Kraften enligt grafen 7 går ej ned till sitt ursprungliga läge på grund av inre friktion i själva kompakteringsverktyget.

I fig 6 illustreras formning av en solid kropp med en slagsekvens omfattande tre stycken slag. I fig 6 betecknas med abskissan tiden medan ordinatan anger stämpelorganets rörelsesträcka. Således kan ur fig 6 utläsas stämpelorganets läge som funktion av tiden, varvid accelerationsfas, formningsfas och stämpelorganets uppåtrörelse framgår för vart och ett av de tre slagen. I fig 7 illustreras en förstoring av det tredje formningssteget (-slaget).

Anordningen enligt uppfinningen är företrädesvis en slagmaskin av en typ liknande den som beskrivits i sökandens tidigare patentansökan WO 97/00751. En sådan slagmaskin utnyttjar företrädesvis hydraulik för att generera de slag eller stötar som åstadkoms medelst ett stämpelorgan 2 mot en materialkropp 1. Anordningen är företrädesvis anordnad så att den kan utföra flera på varandra följande stötserier av det uppfinningsenliga slaget med mycket kort inbördes tidsmellanrum mellan de respektive serierna.

Uppfinningen föreslår ett mycket effektivt och tillförlitligt sätt, på vilket materialkroppar, såväl fasta som mer löst sammansatta av enskilda partiklar, kan deformeras och/eller kompakteras. Den energi som ett stämpel- eller slagorgan uppvisar då det träffar den materialkropp som skall deformeras utnyttjas på bästa möjliga sätt i syfte att generera en så stor deformation som möjligt i materialkroppen. Dessutom kan förekomsten av icke önskade strukturer i den deformerade materialkroppen, vilka uppkommer vid stora temperaturvariationer hos denna, reduceras i jämförelse med då enskilda slag eller slagserier enligt tidigare teknik utnyttjas för att genom adiabatisk koalescens i materialkroppen åstadkomma en deformation av denna.

Naturligtvis kommer ett flertal alternativa utföranden, vilka ligger inom ramen för uppfinningen, att vara uppenbara för en fackman inom området. Uppfinningstanken skall tolkas i sin vidaste me-

ning och såsom den är definierad i de bifogade patentkraven med stöd av beskrivningen och de bifogade ritningarna.

Patentkrav

1. Förfarande för deformation av en materialkropp (1), vid vilket ett stämpelorgan (2) med en massa m förs mot och träffar materialkroppen (1) med en sådan hastighet att åtminstone en återstudsrörelse hos stämpelorganet (2) genereras, under det att en permanent deformation av kroppen genereras, kännetecknat av att återstudsrörelsen motverkas, varigenom åtminstone en ytterligare stöt av stämpelorganet (2) mot materialkroppen (1) genereras inom en period, under vilken kinetisk energi i materialkroppen (1) genererar en ytterligare deformation i denna.

2. Förfarande enligt krav 1, kännetecknat av att under den period, inom vilken kinetisk energi i materialkroppen (1) genererar den ytterligare deformationen i denna, en fram- och återgående våg uppträder igenom åtminstone en del av kroppen, vilken vågrörelse har den kinetiska energi som genererar den ytterligare deformationen.

3. Förfarande enligt krav 1 eller 2, kännetecknat av att återstudsrörelsen motverkas genom att en kraft F tillåts verka på stämpelorganet (2) i riktning mot materialkroppen (1).

4. Förfarande enligt krav 3, kännetecknat av att den riktning i vilken stämpelorganet (2) träffar materialkroppen (1) är sådan att kraften F innefattar åtminstone en del av den gravitationskraft (m·g) som verkar på stämpelorganet (2).

5. Förfarande enligt krav 3 eller 4, kännetecknat av att kraften F innefattar en kraft F_1 som appliceras på stämpelorganet (2) i riktning mot materialkroppen (1).

6. Förfarande enligt något av kraven 1-5, kännetecknat av att en serie stötar appliceras med hjälp av stämpelorganet (2) mot materialkroppen (1) inom nämnda period.

7. Förfarande enligt krav 6, kännetecknat av att serien av stötar åstadkoms genom att en motsvarande serie av återstudsar av stämpelorganet (2) motverkas.

8. Förfarande enligt krav 6 eller 7, kännetecknat av att den impuls, med vilken stämpelorganet (2) träffar materialkroppen (1) sjunker för varje stöt inom nämnda serie.

9. Förfarande enligt något av kraven 6-8, kännetecknat av att efter en första serie av stötar åtminstone en ytterligare serie av stötar appliceras mot materialkroppen (1).

10. Förfarande enligt något av kraven 1-9, kännetecknat av att stämpelorganet (2) bringas att accelerera mot materialkroppen (1) under inverkan av gravitationskraften.

11. Förfarande enligt något av kraven 1-10, kännetecknat av att materialkroppen (1) är en solid kropp som innefattar ett metallmaterial.

12. Förfarande enligt något av kraven 1-11, kännetecknat av att nämnda deformation innefattar en omformning av kroppen.

13. Förfarande enligt krav 11 eller 12, kännetecknat av att den ytterligare deformationen innefattar en successiv aktivering av glidplan i materialkroppen (1).

14. Förfarande enligt något av kraven 1-9, kännetecknat av att materialkroppen (1) innefattar ett pulver, anordnat i en form,

15. Förfarande enligt krav 14, kännetecknat av att den plastiska deformationen av pulverkroppen innefattar en kompaktering därav.

16. Förfarande enligt krav 14 eller 15, kännetecknat av att en fram- och återgående våg uppträder i kroppen under nämnda pe-

riod, vilken har en kinetisk energi som genererar en inbördes förskjutning av pulverkorn, sådan att en kompaktering uppnås.

17. Anordning för deformation av en materialkropp (1), innefattande ett stämpelorgan (2) inrättat att föras mot och träffa en materialkropp (1) med en sådan hastighet att en återstudsrörelse hos stämpelorganet (2) genereras, under det att en permanent deformation av materialkroppen (1) genereras, kännetecknad av att den innefattar medel (3) för att motverka återstudsen och för att generera åtminstone en ytterligare stöt av stämpelorganet (2) mot materialkroppen (1) inom en period, under vilken kinetisk energi i materialkroppen (1) genererar en ytterligare deformation i denna.

18. Anordning enligt krav 17, kännetecknad av att under den period, inom vilken kinetisk energi i materialkroppen (1) genererar en ytterligare deformation av denna, en fram- och återgående våg uppträder igenom åtminstone en del av materialkroppen (1), vilken vågrörelse har den kinetiska energi som successivt genererar den ytterligare deformationen.

19. Anordning enligt krav 17 eller 18, kännetecknad av att stämpelorganets (2) rörelseväg mot materialkroppen (1) är sådan att kroppen accelereras under inverkan av den gravitationskraft som verkar på denna och återstudsen motverkas av gravitationskraften (m·g).

20. Anordning enligt något av kraven 17-19, kännetecknad av att den innefattar medel (3) för att applicera en kraft F_1 på stämpelorganet (2), vilken kraft verkar i riktning mot materialkroppen (1) och motverkar återstudsen.

21. Anordning enligt något av kraven 17-20, kännetecknad av att den är anordnad att utföra en serie stötar medelst stämpelorganet (2) mot materialkroppen (1) inom nämnda period.

22. Anordning enligt krav 21, kännetecknat av att den impuls, med vilken stämpelorganet (2) träffar materialkroppen (1), sjunker för varje stöt inom nämnda serie.

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Sammandrag

Ett förfarande och en anordning för deformation av materialkropp.

Anordningen innefattar ett stämpelorgan (2) inrättat att föras mot och träffa en materialkropp (1) med en sådan hastighet att en återstudsrörelse hos stämpelorganet (2) genereras under det att en permanent deformation av materialkroppen (1) genereras. Anordningen innefattar medel (3) för att motverka återstudsen och för att generera åtminstone en ytterligare stöt av stämpelorganet (2) mot materialkroppen (1) inom en period, under vilken kinetisk energi i materialkroppen (1) genererar en ytterligare deformation i denna.

(Fig. 1)

1/4

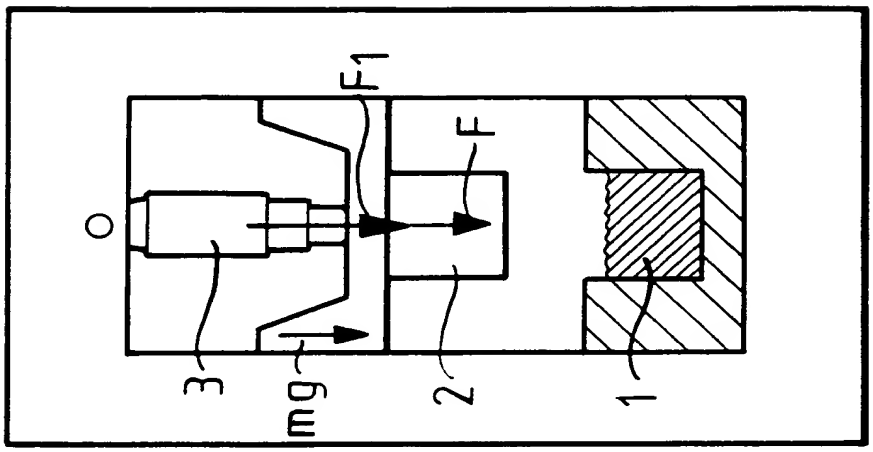

FIG 2

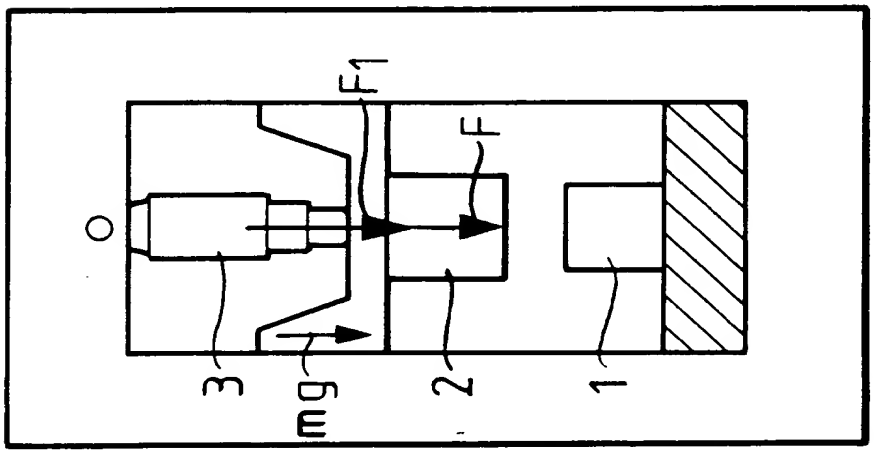

FIG 1

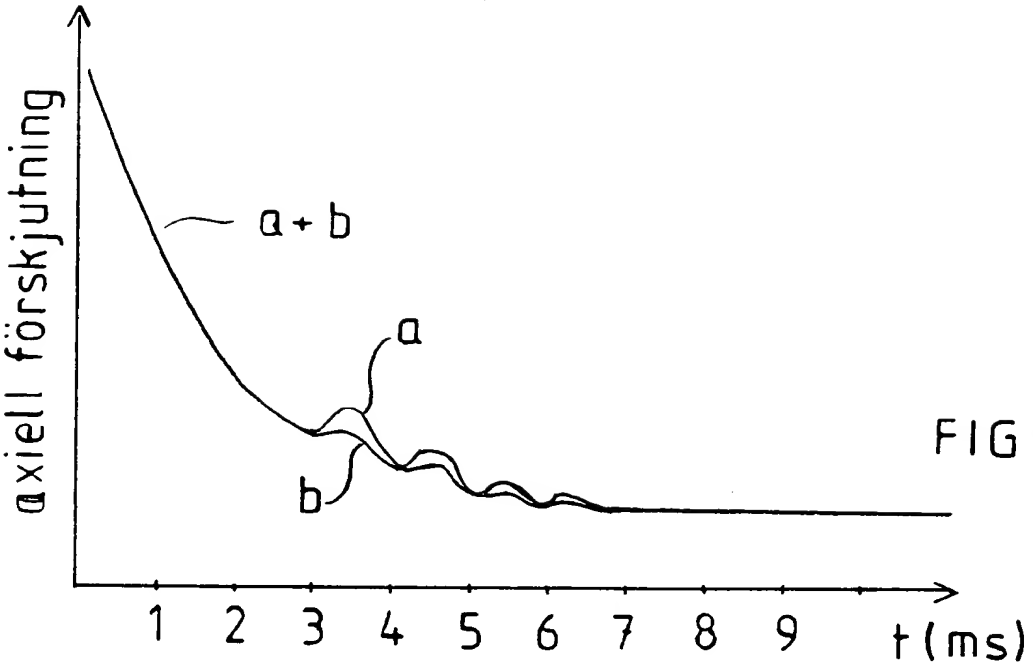
axiell förskjutning
a + b
a
b
1 2 3 4 5 6 7 8 9
t (ms)

FIG 3

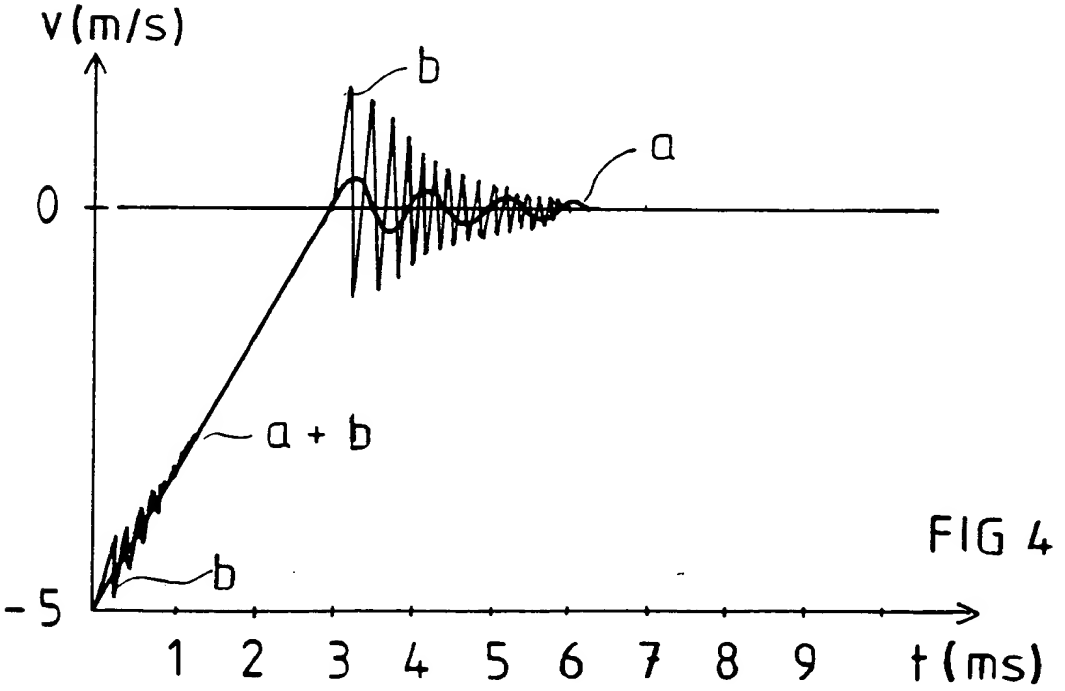
v (m/s)
b
a
0
a + b
b
-5
1 2 3 4 5 6 7 8 9
t (ms)

FIG 4

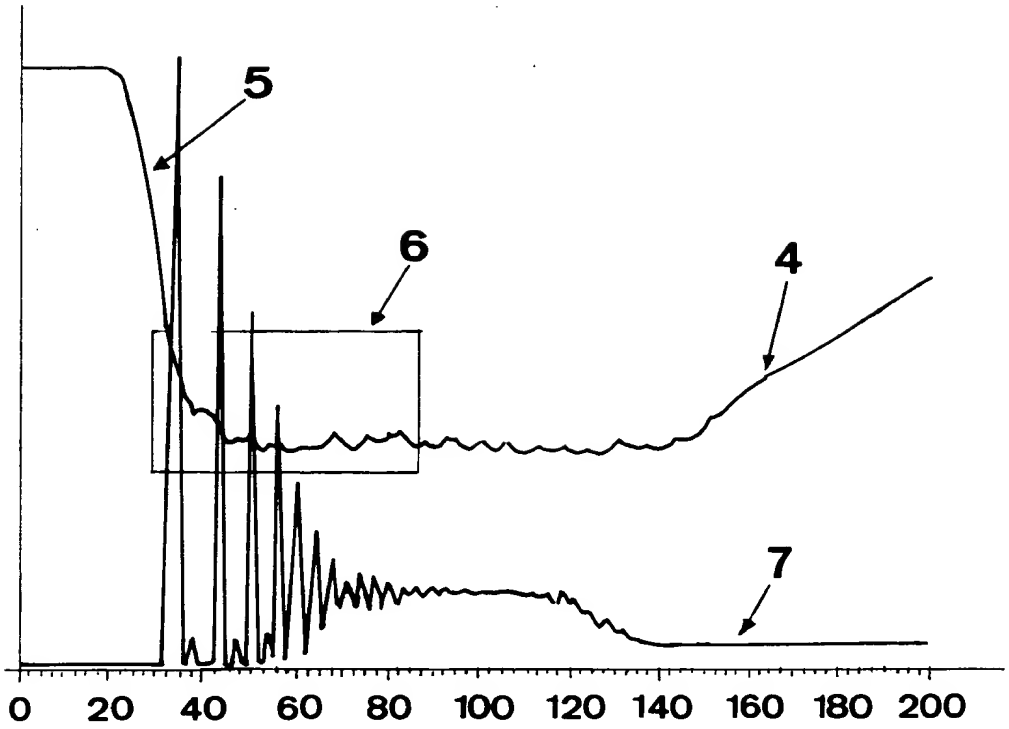

Fig 5

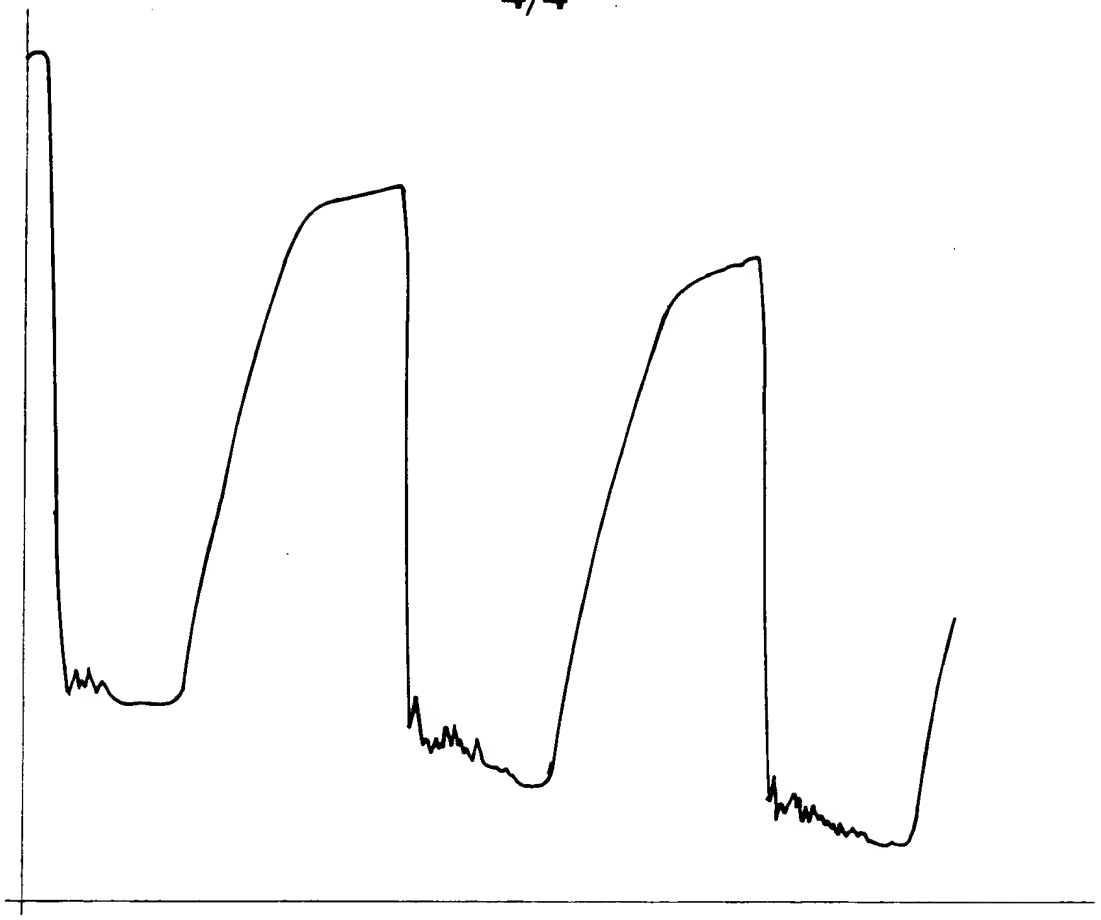

Fig 6

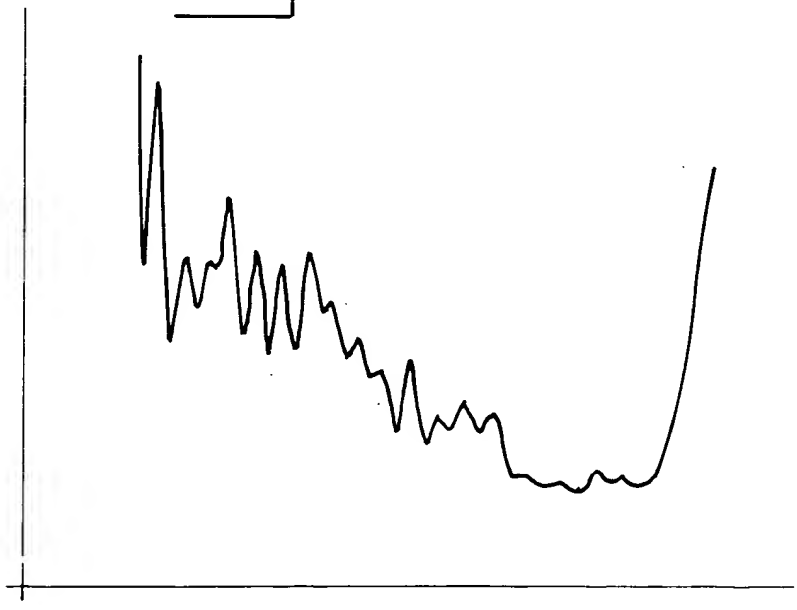

Fig 7

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B22F 3/02, B21J 5/00

A1

(11) International Publication Number: **WO 00/30788**

(43) International Publication Date: 2 June 2000 (02.06.00)

(21) International Application Number: PCT/SE99/02127

(22) International Filing Date: 19 November 1999 (19.11.99)

(30) Priority Data:
9803956-3 19 November 1998 (19.11.98) SE

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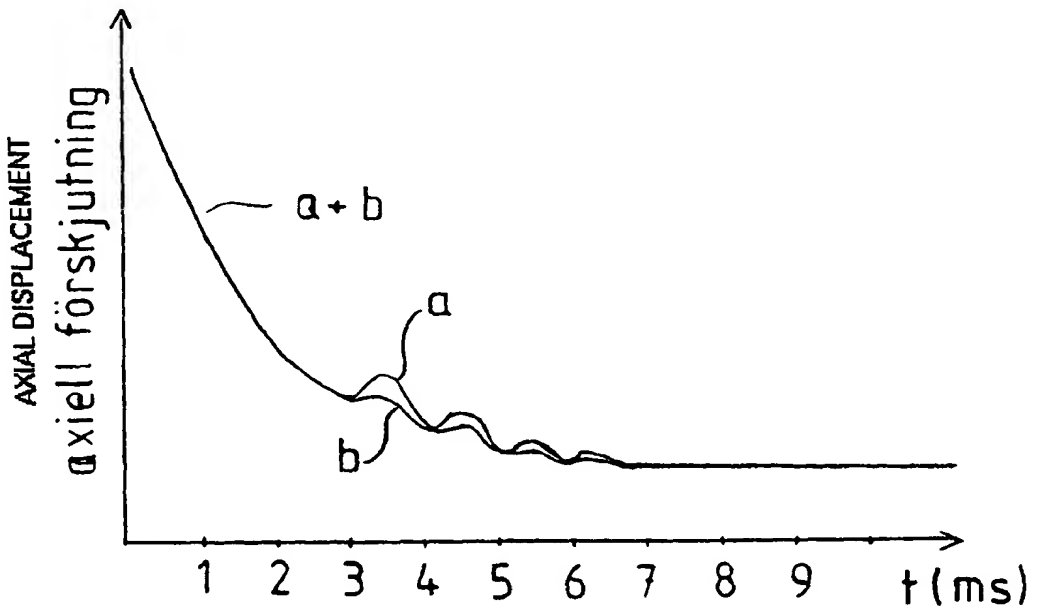
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), DM, EE, ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: A METHOD AND A DEVICE FOR DEFORMATION OF A MATERIAL BODY



(57) Abstract

The device comprises a stamping member (2) arranged to be conveyed towards and hit a material body (1) with such a velocity that a rebound motion of the stamping member (2) is generated while a permanent deformation of the material body (1) is generated. the device comprises means (3) for counteracting the rebound and generating at least one additional impact of the stamping member (2) against the material body (1) within a period, during which kinetic energy in the material body (1) generates an additional deformation in the body.

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A method and a device for deformation of a material body

BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention is related to a method for deformation of a material body, in which a stamping member with a mass m is conveyed towards and hits a material body with such a velocity that at least one rebound motion of the stamping member is generated, while a permanent deformation of the body is generated. The invention also relates to a device for deformation of a material body, comprising a stamping member arranged to be conveyed towards and hit a material body with such a velocity that a rebound motion of the stamping member is generated, while a permanent deformation of the material body is generated.

Through the earlier patent application No. WO 97/00751 of the applicant it is known to fix a material body, either in solid form or in form of a powder of grain, pellets or similar and with one single or several consecutive strokes by means of a striking unit achieve adiabatic coalescence in the material body, through which a fast and effective deformation of the material body is obtained.

According to this prior art, when a plurality of consecutive strokes is applied to the body, the interval between the consecutive strokes should be smaller than approximately 0,2 seconds. At compacting of powder, preferably metal powder, it is suggested that three consecutive strokes are applied to the

material body. Of these strokes, the first one is an extremely light stroke forcing the most of the air out of the powder and orientating the powder particles. The next stroke has very high energy and high striking velocity in order to achieve local adiabatic coalescence of the powder particles so that these are pressed together to extremely high density. The third stroke has medium high energy, i.e. lower energy than the second stroke, and achieves final shaping of the material body, which subsequently can be sintered. At corresponding deformation of a solid metal body, sliding planes will be activaterd during a large local temperature increase in the material, through which the required deformation is achieved.

In both the described cases, however, a very powerful impulse from the striking unit will be required to achieve the intended deformation effect when one single stroke or several strokes at intervals of in the order 200 ms are used to achieve the desired goal. The striking tool, or the stamping member, is allowed to bounce back between every single stroke. It is thereby not in contact with the material body between the strokes, only once per stroke. The stroke or the strokes give a locally very powerful increase of the temperature in the material of the deformed body. When the material of the body comprises one or several metals or metal alloys, such a powerful temperature increase usually results in phase transitions of the material, both when heating it and subsequently cooling it. The cooling can further often be done relatively fast, since the temperature increase often is local and the heat can be carried off via the surrounding, colder material. The probability is high that unwanted structures and phases, for instance martensite in steel, are obtained as a result of this process.

SUMMARY OF THE INVENTION

An object with the present invention is to provide a method, by means of which a deformation of a material body of the initially

mentioned kind is performed with as low a temperature increase in the material body as possible while still achieving a satisfactory deformation of the material body. Thereby the method should to a great extent enable the emergence of disadvantageous phases and structures in the material body due to too strong temperature variations in it.

The inventor has at practical experiments discovered that reciprocating waves are generated in the material body at the moment when the stamping member bounces back from the material body. These waves define a kinetic energy in the material body, which energy gradually, in sequences, activates planes in the body and probably also causes mutual displacements of grain of a powder while said waves fast subside. Attempts have been made with material bodies of steel, placed on a base and deformed by means of a stamping member, which has hit these vertically from above. In connection with that it has been noted that the reciprocating waves move forth and back essentially in the impact direction of the stamping member, i.e. from the surface of the material body hit by the stamping member to the surface which abuts against the base and back. At such test material bodies of steel, said waves subside so much that they no longer generate any considerable deformation in the material within a few milliseconds.

The object of the invention has been achieved by means of a method of the initially mentioned kind, which is characterized in that the rebound motion of the stamping member is counteracted, through which at least one additional impact of the stamping member against the material body is generated within a period, during which kinetic energy in the material body generates an additional deformation in the body. The at least one additional impact thereby supplies energy to the material body to such an extent that it contributes to the kinetic energy of the reciprocating wave, through which an additional deformation of the body achieved by said wave continues during a longer pe-

riod than if not any immediate return impact of the stamping member has been performed. The additional deformation achieved by the wave can comprise only sliding plane activation, and/or mutual displacements of grain in the case of a powder body. The additional impact, having a certain impulse and supplying a certain energy, will, thanks to the additional deformation established by the wave, further plastically deform the body. A substantially smaller impulse is required for a given deformation at this time, when more sliding planes are activated, than would have been the case if the additional impact had been applied at a later occasion, when said wave had already subsided.

The inventor has discovered that a lower total energy needs to be supplied to the material body and that a comparatively low temperature increase in the material body can be achieved while still achieving the desired deformation of the material body by means of the method according to the invention.

According to a preferred embodiment of the method according to the invention, a series of impacts is applied by means of the stamping member against the material body within said period. Through a series of fast impacts, the material body is continuously supplied kinetic energy which contributes to keeping the reciprocating wave alive and consequently favours further generation of the additional deformation in the material body at the same time as each new impact generates an additional plastic, permanent deformation of the body. The series of impacts is achieved in that a corresponding series of rebounds of the stamping member is counteracted and a new respective impact is achieved, which in its turn generates a new rebound. Every impulse, with which the stamping member hits the material body is consequently large enough to generate a rebound of the stamping member within said series. When several consecutive strokes are applied against the material body for deformation of it, said series of impacts is applied in direct connection with the

respective stroke. The stroke defines the first impact in the respective series of impacts.

According to a further preferred embodiment the impulse, with which the stamping member hits the material body, decreases with each impact within said series. When a stroke only comprising two impacts, a first and a second one, is applied against the material body, the first impact has a larger impulse than the second. Thanks to the effect of the wave on the material body, such a large impulse from the second impact is no longer necessary to generate a certain desired additional plastic deformation. Also in practice it becomes easier to achieve a second impact with a smaller impulse than the first impact within such a short period of time here referred to (approximately 1 ms), for instance by effective damping of the rebound motion. The possibility to apply a second impact with a larger impulse than the first or previous impact shall however not be excluded, if required.

According to another preferred embodiment the material body is a solid body comprising a metal material, said deformation comprising a reshaping of the body. The additional deformation is thereby done in that the kinetic energy of the reciprocating wave generates a gradual activation of sliding planes in the material body. Since the sliding planes are activated gradually, a slower and less intense deformation of the material can be achieved by the application of one or several additional impacts besides the first against the material body. The temperature increase in the material body hereby does not need to be as large as when a corresponding deformation of the body shall be achieved by means of one single impact, after which the reciprocating wave in the material body is allowed to subside without any additional energy being supplied hereto from outside.

According to a further preferred embodiment the material body comprises a powder, provided in a mould. The deformation of

the powder body comprises a compacting thereof. The method according to the invention offers a fast and effective way of compacting powder, for instance cemented carbide powder, without any unnecessarily high temperatures, which could lead to forming of undesired structures and/or phases being generated in the powder. As mentioned above, the prior art suggests that the powder material body is compacted in three steps, a first step when a light stroke is applied against the body in order to achieve an initial orientation of the powder particles, a second step when a very powerful stroke is directed against the powder to achieve local adiabatic coalescence of the powder particles so that these are pressed together to high density, and a third step, at which a stroke of medium high energy is applied against the powder body and a final forming takes place. The method according to the invention could with advantage be applied at the second step and/or possibly at the third step.

A further object of the invention is to provide a device, by means of which it is possible to work a material body by means of a stamping member hitting the material body with such an impulse that an adiabatic coalescence is obtained in the material body, at which a minimum temperature increase is achieved in the body at the same time as the deformation aimed at is obtained.

This object is obtained by means of a device of the initially defined kind, characterized in that it comprises means for counteracting the rebound and for generating one additional impact of the stamping member against the material body within a period, during which kinetic energy in the material body generates an additional deformation herein.

According to a preferred embodiment, the path of motion of the stamping member towards the material body is such that the body is accelerated under the influence of the gravity force acting on it and the rebound is counteracted by the gravity

force. Thereby the own mass of the stamping member can be used for generating the additional impact directed against the body. Preferably the stamping member is allowed to drop substantially vertically in the direction of the material body, through which the gravity force is used maximally to counteract the rebound of the stamping member.

According to a further preferred embodiment, the device comprises means for application of a force F_1 to the stamping member, which force acts in the direction towards the material body and counteracts the rebound. By a suitable choice of the mass of the stamping member, the drop and the size of the force F_1 applied it is consequently possible to control the time between two consecutive impacts of the stamping member against the material body. The applied force F_1 not only counteracts the rebound but also contributes to actively pushing the stamping member in the direction towards the material body.

According to a further preferred embodiment, the device is arranged to perform a series of impacts by means of the stamping member against the material body within said period. Every single impact thereby takes place with such a velocity of the stamping member that a following rebound of it is generated. The device can thereby comprise means for controlling the size of the force applied on the stamping member, for instance so that it gradually subsides with every additional rebound in order to achieve a harmonic and not too fast a damping of the motions of the stamping member against the material body.

According to a further preferred embodiment, the impulse, with which the stamping member hits the material body, decreases with each impact within said series. Above all the difference in impulse between the first impact and the second impact is large. The respective impulses contribute to preventing the reciprocating wave in the material body from subsiding too fast. In this manner energy is supplied in the form of kinetic energy to the

material body within a period, during which the kinetic energy in the most effective way generates a deformation in the material body. As mentioned above, the additional deformation generated by the wave in the body comprises activation of sliding planes. Each additional impact within said period benefits therefrom for generating an additional plastic deformation of the material body while said sliding planes are still activated.

Further characteristics and advantages of the invention will be apparent from the following description and from the other patent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will hereinafter be described for exemplifying purposes with reference to the enclosed drawings, in which;

Fig 1 is a schematic cross-sectional view from the side, showing a device for deformation of a solid body,

Fig 2 is a schematic cross-sectional view from the side, showing a similar device for compacting of a powder,

Fig 3 is a diagram schematically showing a registered displacement of a stamping member according to Fig 1 or 2 in time,

Fig 4 is a diagram schematically showing the axial velocity of the stamping member and a surface of the material body respectively, according to Fig 1 in time,

Fig 5 is a diagram showing, in an experiment with powder compacting, both the motion of the stamping member in time and the force with which the stamping member influences the powder material during the course of compacting,

Fig 6 is a diagram describing the position of the stamping member as function of time at deformation (forming) of a solid body, and

Fig 7 is an enlargement of the third forming step evident from Fig 6.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In Figs 1 and 2 a device for deformation of a material body 1 is shown schematically. The device comprises a stamping member 2, arranged to be conveyed towards and hit the material body 1 with such a velocity that a rebound motion of the stamping member 2 is generated. Thereby the material body 1 is deformed.

The material body in Fig 1 is formed by a material in solid form, preferably a solid metal. In Fig 2 the material body 1 is formed by a powder preferably already being lightly compacted, either by means of a light stroke of the stamping member or some other similar member. The device is arranged to achieve an immediate and relatively large deformation of the material body 1 by means of a powerful stroke of the stamping member.

The stamping member 2 is so provided that it under influence of the gravity force acting on it is accelerated towards the material body 1. The mass m of the stamping member 2 is preferably substantially larger than the mass of the material body 1. Thereby the need for a high impact velocity of the stamping member 2 can be reduced somewhat. The stamping member 2 is allowed to hit the material body 1 with such a velocity that a local adiabatic coalescence and a deformation in the material body 1 associated therewith is obtained. The velocity is furthermore such that a rebound of the stamping member 2 is generated. The deformation of the material body 1 thereby achieved is plastic and consequently permanent. When the

stamping member 2 rebounds, strong waves or vibrations in the material body 1 is generated in the striking direction of the stamping member 2. The waves are initially amplified when the stamping member 2 is not in immediate contact with the material body 1. This wave or these waves have a high kinetic energy and will activate sliding planes in the material body, which have not been activated during the previous impact. During the period, when these sliding planes are activated, the material body 1 will be relatively easier to deform with a given impulse or energy of a next following impact. The device is therefore so provided that a sufficient force acts on the stamping member 2 in the direction towards the material body 1 because an additional impact, with an impulse exceeding a minimum value, is generated against the material body 1 within said period. The period is however very short, in the order of a few milliseconds. If the mass of the stamping member 2 is very large it could in fact be possible to achieve said additional impact within this period by only letting the gravity force act on the stamping member 2 and damp the rebound and accelerate the stamping member 2 against the material body 1.

According to the shown preferred embodiment of the device, the latter however comprises a means 3 for application of a force F_1 on the stamping member 2, which force acts in the direction towards the material body 1 and counteracts the rebound. This means 3 can comprise a force cylinder, for instance a hydraulic cylinder. The purpose of it is not only to counteract the rebound motion of the stamping member 2, but also to accelerate the stamping member 2 towards the material body 1 and thereby contribute to the impulse, with which the stamping member 2 hits the material body 1 at the following impact. Preferably the force F_1, the moving path of the stamping member 2 and the direction of motion towards the material body 1 and the mass m of the stamping member 2 are adapted so that an additional impact, preferably several additional impacts, each contributing to

extend said period and in steps further plastically deform the material body 1 are generated.

Fig 3 schematically shows the axial displacement of the stamping member 2 in time from the moment when the stamping member 2 hits the material body 1 and starts to deform it to the time, when the wave or waves in the material body have subsided and additional possible rebounds and impacts from the stamping member no longer generate any substantial additional deformation of the material body 1. The diagram is created from a test, at which a stamping member 2 with a mass of 105 kg was used for deformating a cylinder with the height 20 mm and the diameter 12 mm, made of soft annealed bearing steel. By means of a hydraulic piston in addition 50 kN was applied to the stamping member 2 in the direction towards the material body 1, i.e. the steel cylinder.

The velocity, with which the stamping member 2 was allowed to hit the material body 1 was varied at different tests. At the test generating a diagram, approximately corresponding to the diagram of Fig 3, velocities in axial direction of the stamping member 2 was measured and from a calculation model a schematic image over a typical velocity of the material body 1 in axial direction was obtained, which velocities are approximately illustrated in Fig 4. The line a indicates the velocity of the stamping member and line b indicates the velocity of the material body. It is evident how a wave, i.e. a reciprocating motion, is generated in the material body 1 as soon as the rebound motion of the stamping member 2 has begun. This occurs in the illustrated test after approximately 3 ms. One millisecond later, i.e. after 4 ms, the device performs the next impact.

At the impact moment, when the stamping member 2 and the material body 1 are in contact with each other and the material body 1 is deformed under the influence of the impulse of the stamping member 2, the amplitude of the wave in the material

body 1 subsides somewhat, to then increase in size again when the stamping member 2 again bounces back and completely or partly looses contact with the material body 1 for a short moment. The period between two consecutive impacts is in the order of 1 ms. After a certain time, here in the order of 5 ms, the wave in the material body 1 has, however, subsided so much that it no longer contributes to activation of additional sliding planes. Additional impacts from the stamping member 2 will thereby not to any considerable extent contribute to any additional plastic deformation of the material body 1, as long as not any radical measures are taken, for instance a prominent increase of the power, with which the stamping member 2 is influenced. When this stage has been achieved the stamping member can suitably be returned to a position, from which a new, corresponding series of impacts against an additional material body 1 or the same material body 1 is performed.

It should be mentioned that a reciprocating wave can appear in the material body 1 also during the initial plastic deformation of it, i.e. before the rebound motion of the stamping member 2 has been generated, but that this wave has a substantially lower amplitude than when the rebound motion has been generated. For the sake of clarity no reciprocating wave of the material body 1 at the initial deformation thereof is shown in Fig 4.

In Fig 5 the abscissa denotes the time (milliseconds) while the ordinate denotes the motion distance of the stamping member with reference to the graph indicated with 4 while the ordinate refers to force concerning the graph indicated with 7. As previously mentioned, the stamping member describes a rebound motion during a forming step. In the diagram according to Fig 5 the graph 4 shows the motion of the stamping member at the performed experiment with powder compacting. The graph 7 describes the force with which the stamping member influences the powder material being compacted.

From the diagram in Fig 5 it can be seen, with reference to the compacting phase indicated with 6, how the force (the graph 7) in the powder material increases at every rebound of the stamping member, see the graph 4. Further it is evident how the stamping member takes an increasingly lower position after every rebound, see the graph 4, and thereby gives the powder material an increasingly higher degree of compacting. After the motion of the stamping member has subsided, the stamping member sooner or later is manoeuvred up to the parking position according to graph 4. The force according to the graph 7 does not decrease to its original position due to inner friction in the compacting tool itself.

In Fig 6 forming of a solid body with a striking sequence including three strokes is illustrated. In Fig 6 the abscissa indicates the time while the ordinate indicates the motion distance of the stamping member. Consequently, from Fig 6 the position of the stamping member as function of the time can be gathered, acceleration phase, forming phase and upward motion of the stamping being evident for each of the three strokes. In Fig 7, an enlargement of the third forming step (stroke) is illustrated.

The device according to the invention is preferably a striking machine of a type similar to the one described in the previous patent application WO 97/00751 of the applicant. Such a striking machine uses preferably hydraulics to generate the strokes or impacts achieved by means of a stamping member 2 against a material body 1. The device is preferably arranged so that it can perform several consecutive series of impacts of the kind according to the invention with very short mutual time space between the series, respectively.

The invention proposes a very effective and reliable way, in which material bodies, solid as well as more loosely put together from single particles, can be deformed and/or com-

pacted. The energy that a stamping or striking member exhibits when it hits the material body which is to be deformed is used in the best possible way in order to generate as large a deformation as possible in the material body. In addition, the presence of unwanted structures in the deformed material body, arising at large temperature variations in it, are reduced compared to when single strokes or stroke series according to prior art is used to achieve a deformation of it through adiabatic coalescence in the material body.

Of course a plurality of alternative embodiments, lying within the scope of the invention, will be obvious for a man skilled in the art. The idea of the invention shall be interpreted in its widest sense and as defined in the enclosed patent claims with support of the description and the enclosed drawings.

Claims

1. A method for deformation of a material body (1), in which a stamping member (2) with a mass m is conveyed towards and hits the material body (1) with such a velocity that at least one rebound motion of the stamping member (2) is generated, while a perrmanent deformation of the body is generated, ***characterized*** in that the rebound motion is counteracted, through which at least one additional impact of the stamping member (2) against the material body (1) is generated within a period, during which kinetic energy in the material body (1) generates an additional deformation in the body.

2. A method according to claim 1, ***characterized*** in that during the period, within which kinetic energy in the material body (1) generates the additional deformation in the body, a reciprocating wave appears through at least a part of the body, the wave motion having the kinetic energy generating the additional deformation.

3. A method according to claim 1 or 2, ***characterized*** in that the rebound motion is counteracted in that a force F is allowed to act on the stamping member (2) in the direction towards the material body (1).

4. A method according to claim 3, ***characterized*** in that the direction in which the stamping member (2) hits the material body (1) is such that the force F comprises at least a part of the gravity force (m·g) acting on the stamping member (2).

5. A method according to claim 3 or 4, ***characterized*** in that the force F comprises a force F_1, which is applied to the stamping member (2) in the direction towards the material body (1).

6. A method according to any of claims 1-5, ***characterized*** in that a series of impacts is applied by means of the stamping member (2) against the material body (1) within said period.

7. A method according to claim 6, ***characterized*** in that the series of bounces is achieved in that a corresponding series of rebounds of the stamping member (2) is counteracted.

8. A method according to claim 6 or 7, ***characterized*** in that the impulse, with which the stamping member (2) hits the material body (1) decreases with each impact in said series.

9. A method according to any of claims 6-8, ***characterized*** in that after a first series of impact at least one additional series of impacts is applied to the material body (1).

10. A method according to any of claims 1-9, ***characterized*** in that the stamping member (2) is caused to accelerate towards the material body (1) under the influence of the gravity force.

11. A method according to any of claims 1-10, ***characterized*** in that the material body (1) is a solid body comprising a metal material.

12. A method according to any of claims 1-11, ***characterized*** in that said deformation comprises a reshaping of the body.

13. A method according to claim 11 or 12, ***characterized*** in that the additional deformation comprises a gradual activation of sliding planes in the material body (1).

14. A method according to any of claims 1-9, ***characterized*** in that the material body (1) comprises a powder, provided in a mould.

15. A method according to claim 14, ***characterized*** in that plastic deformation of the powder body comprises a compacting thereof.

16. A method according to claim 14 or 15, ***characterized*** in that a reciprocating wave appears in the body during said period, which has a kinetic energy generating a mutual displacement of powder grains, such that a compacting is achieved.

17. A device for deformation of a material body (1), comprising a stamping member (2) arranged to be conveyed towards and hit a material body (1) with such a velocity that a rebound motion of the stamping member (2) is generated, while a deformation of the material body (1) is generated, ***characterized*** in that it comprises means (3) for counteracting the rebound and for generating at least one additional impact of the stamping member (2) against the material body (1) within a period, during which kinetic energy in the material body (1) generates an additional deformation in the body.

18. A device according to claim 17, ***characterized*** in that during the period, within which kinetic energy in the material body (1) generates an additional deformation of the body, a reciprocating wave appears through at least a part of the material body (1), the wave motion having the kinetic energy which gradually generates the additional deformation.

19. A device according to claim 17 or 18, ***characterized*** in that the path of motion of the stamping member (2) towards the material body (1) is such that the body is accelerated under the influence of the gravity force acting on it and the rebound is counteracted by the gravity force ($m \cdot g$).

20. A device according to any of claims 17-19, ***characterized*** in that it comprises means (3) for application of a force F_1 to

the stamping member (2), which force acts in the direction towards the material body (1) and counteracts the rebound.

21. A device according to any of claims 17-20, ***characterized*** in that it is arranged to perform a series of impacts by means of the stamping member (2) against the material body (1) within said period.

22. A device according to claim 21, ***characterized*** in that the impulse, with which the stamping member (2) hits the material body (1), decreases with each impact within said series.

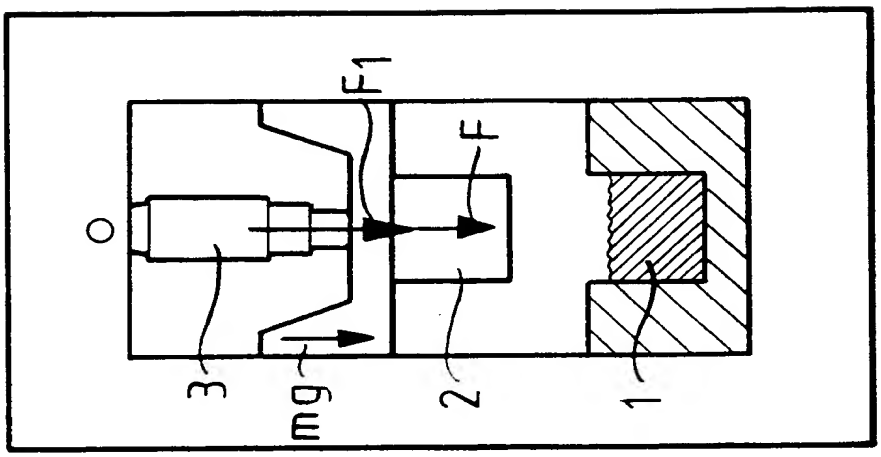

FIG 2

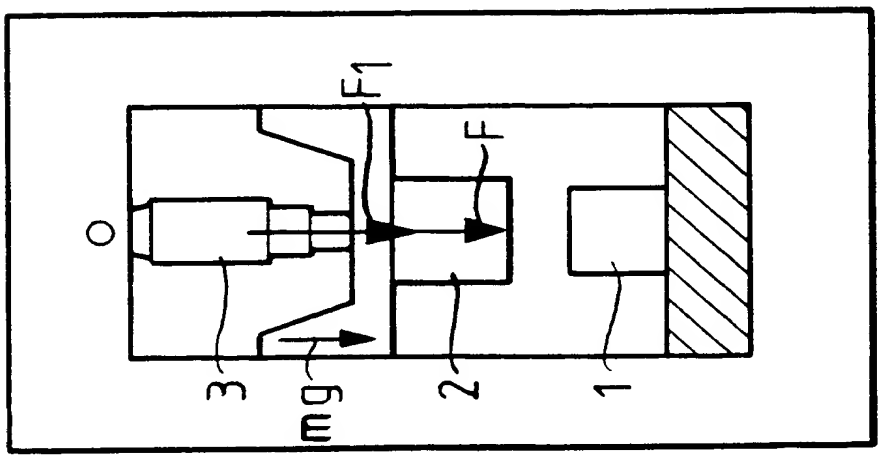

FIG 1

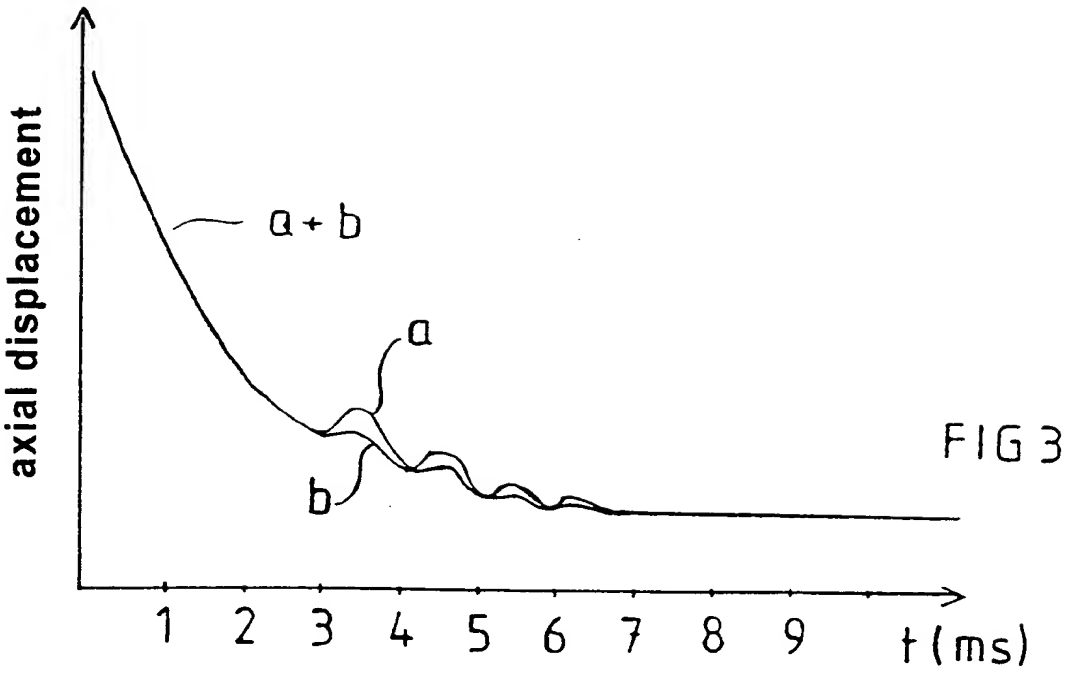
axial displacement
a + b
a
b
1 2 3 4 5 6 7 8 9
t (ms)

FIG 3

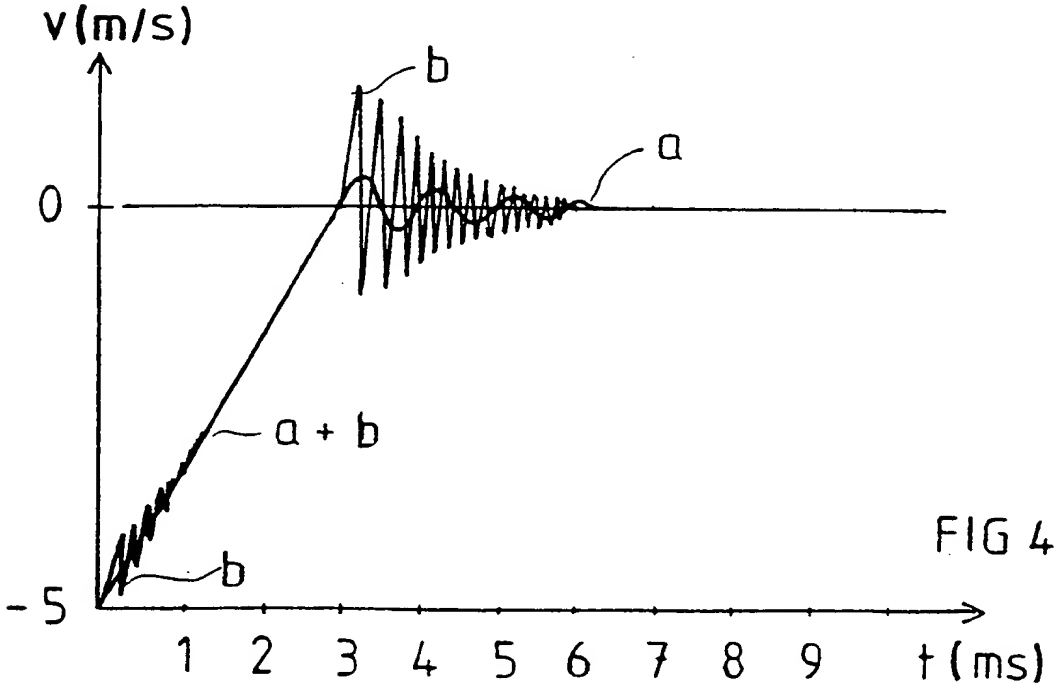
v (m/s)
b
a
0
a + b
b
- 5
1 2 3 4 5 6 7 8 9
t (ms)

FIG 4

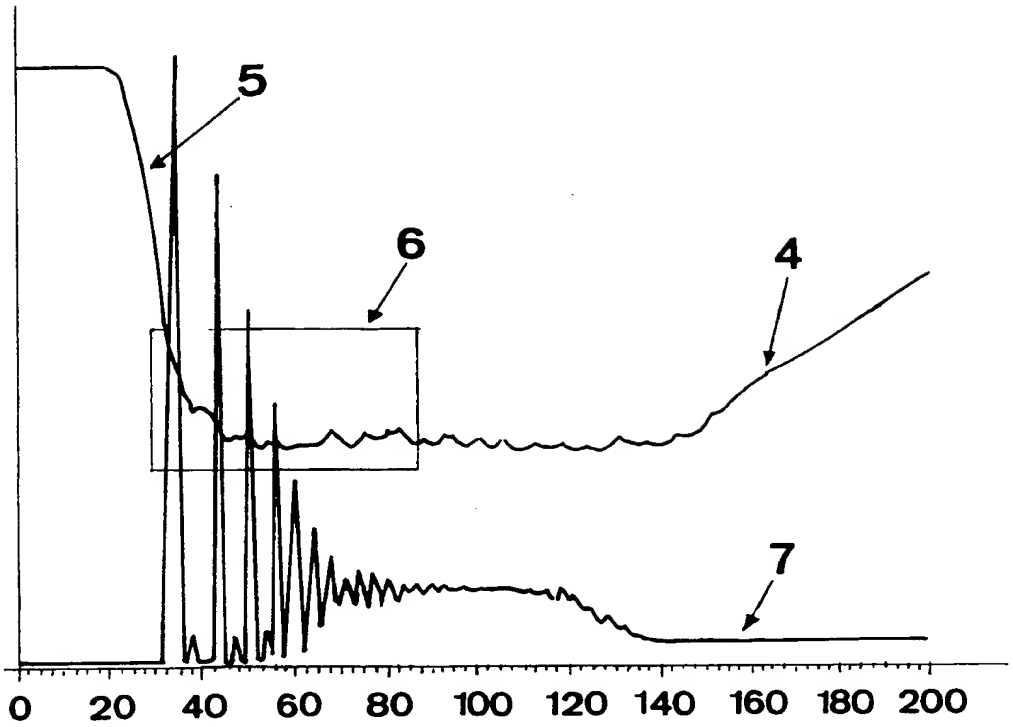

Fig 5

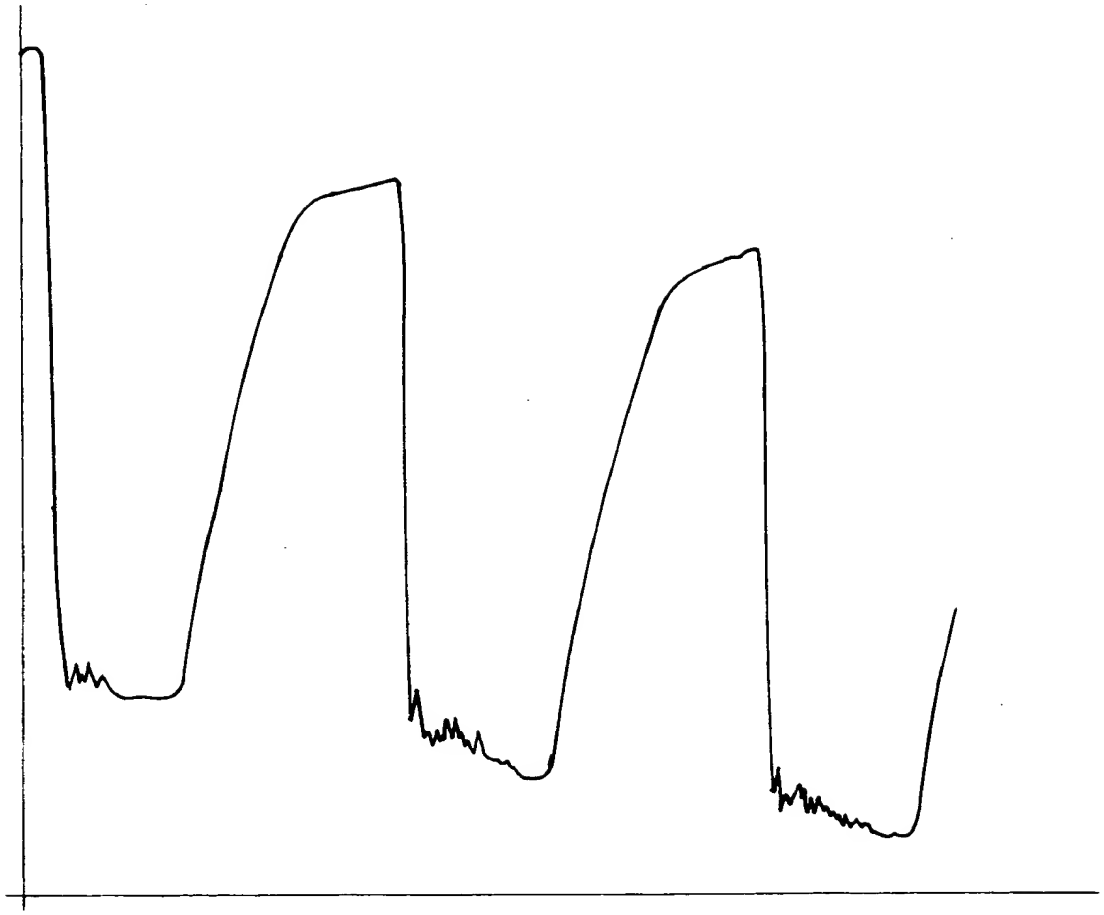

Fig 6

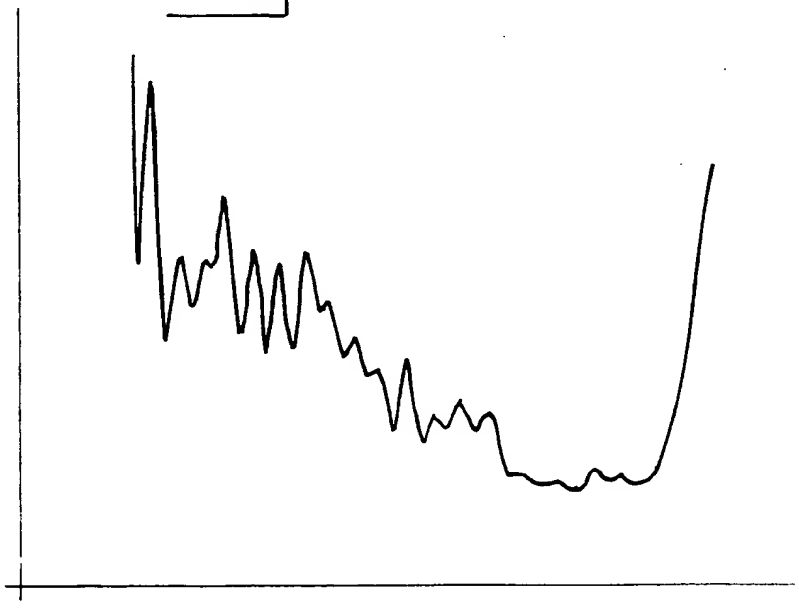

Fig 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/02127

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B22F 3/02, B21J 5/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B22F, B21J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, US PATFULL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9700751 A1 (HYDROPULSOR AB), 9 January 1997 (09.01.97), page 1, line 1 - page 3, line 24, claim 23 --	1-22
A	DE 2338221 A1 (BECHE & GROHS GMBH), 13 February 1975 (13.02.75), page 2, line 10 - line 21; page 3, line 17 - line 23 --	1-22
A	Derwent's abstract, No 48412 B/26, week 7926, ABSTRACT OF SU, 621434 (KALIN MECH ENG WKS (MOST)), 24 July 1978 (24.07.78) --	1-22

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 February 2000	13 -03- 2000
Name and mailing address of the ISA: Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Nils Engnell/MP Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/02127

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0022433 A1 (INSTITUT CERAC S.A.), 14 January 1981 (14.01.81) --	1-22

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Information on patent family members

02/12/99

International application No.
PCT/SE 99/02127

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